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Edge Based Image Segmentation with Vitamin-D Disorder

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Abstract —Image segmentation has a importance in most medical imaging applications by retrieving an anatomical erections from medical images. There are various image segmentation techniques are available in the narrative, each of them having merits and demerits. Recently, the research going on image segmentation field, the extraction of bone contours from vitamin-D disorder images has received a significant amount of attention. Because they represent a fundamental step in the computer analysis of this kind of images. The aim of edge based image segmentation is to subdivide the image in several portions, so that it can help doctors during the learning of the bone structure, for the revealing of the disease of rickets and Osteomalacia in bones, or for setting up the treatment before surgery. The main objective of this paper, to review the most important edge based image segmentation method starting from a database composed by genuine Vitamin-D disorder images. We will examine the opinion and the mathematical model for each method, highlighting the strengths and weaknesses.

Keyword: image processing, image segmentation, Vitamin-D disorder imaging, digital images.

I. INTRODUCTION

Image segmentation is one of the most challenging issues in image processing domain and it has been an active research area in the last several years. Through segmentation, we aim to fragment the image in a series of edges based on the attributes of the image that are approximately constant in each edge, but differ significantly from a region to another. Segmentation aims to extract useful information from images in Vitamin-D Disorder applications as well. Actual medical imaging provides perspectives for a major progress in medicine and science, as higher quality images are generated [3]. Then, various image modalities have appeared over the years, each with their own advantages and disadvantages. These are: Magnetic Resonance Imaging (MRI), Ultrasound (US), Computed Tomography (CT) and Nuclear Imaging including Single Photon Emission Computed Tomography (SPECT) and Position Emission Tomography (PET). Among the applications of segmentation in medical imaging we mention the anatomical localization, whose main purpose is to describe anatomic regions of interest. Vitamin-D Deficiency has also found applications in studying the anatomical structure of the bone, dietary sources of vitamin-D and actual disease of vitamin-D deficiency. The following are the symptoms of those diseases: Bowed legs, Depreciated bone because of low nutrients.

Vitamin-DX-ray segmentation is challenging as X-ray images have a complex nature. They may be also affected by noise, sampling artifacts or spatial aliasing so that the boundaries of the regions of interest to become indistinct or disconnected. X-rays may have various orientations, resolutions, or luminous intensities, depending on the X-ray equipment, that could influence the quality of the segmentation result. Unlike other medical imaging modalities, bone regions in X-rays often overlap with other organs or bones. Another problem to be considered is represented by the joints between bones. When we aim to segment the Vitamin-D disorder image, the bowed legs and depreciate legs because of the low nutrients to be considered. Several segmentation techniques have been developed and reported in the literature. However, a perfect method, universally applicable to all kind of images, does not exist. This paper focus on the edge based segmentation technique for the vitamin-D disorder disease like rickets and Osteomalacia.

II. VITAMIN-D DISORDER

Description

Vitamin-D is a fat-soluble vitamin which exists in many forms. It is mainly used by humans is called cholecalciferol also known as Vitamin-D_3. This vitamin is generated when cholesterol in the skin is explored to ultraviolet sunlight. It has physiological effects which are first modified in the human body. It varies from other necessary vitamins because our specific bodies can generate through sunlight exposure. The main scope of Vitamin-D is to regularize the inclusion of calcium and phosphorus in human bones and transfer from cell to cell communication throughout the human body. Continuous exposure of the skin to sunlight provides sufficient Vitamin-D synthesis without the requisite for supplement, Anyway, adults who have darker skin pigmentation or continuously wear sun protection when outdoor activities are often Vitamin-D deficient. Five forms of Vitamin-D have been defined such as Vitamin-D_1, D_2, D_3, D_4, D_5. The two procedures had been seems to matter for humans the most are vitamins D_2 is known as ergocalciferol and D_3 known as cholecalciferol.

Functions

Vitamin-D is mainly for developing the growth of bone and density for functioning in the nervous system. The regulation is defined by Vitamin-D endocrine system; it functions in a way alike to the thyroid hormone. It is also focus on heart functioning. It plays a major role in calcium metabolism. Deficiency determines child bone mineralization failure, worst growth, bone deformities which means osteoporosis and joint pain. It also impedes with T lymphocyte-mediated immunity which means that antigens of xenobiotics is also known as foreign substances in the human body are no longer recognized and also autoimmune disease might be occur. Auto immune disease which causes the immune system which affects isolated body cells, rather than xenobiotics. Vitamin-D is usually determined from sunlight, and also some food stuffs provides vitamin such as embrace dairy products, fish oil, liver and egg yolk.

Vitamin-D as a supplement

Vitamin-D medication is preferred to human beings on fat diets, vegans and people that are commonly not visualize to bright sunlight or they moved to regions with a colder climate. Calcitriol is a synthesized form of Vitamin-D, which can be applied in case of psoriasis. It is a skin disorder affects rapid proliferation which means rapid cell division as observed in case of skin wounds of cells. It leads to the belief that Vitamin-D might aid cancer treatment and prevention from it. There is a correlation between Vitamin-D deficiency and certain kinds of cancer, such as prostate cancer.

Interactions

A calcium deficit leads to a lack of Vitamin-D adsorption and vice versa. It increases bone calcium mobilization and calcium reads option through the kidneys. Long-term handling with anti-epilepsy medication can also disturb hepatic metabolism of Vitamin-D. Cholesterol-lowering medication and antifungal drugs may lead to decrease intestinal adsorption.

Prevention

Insufficiency is a very much preventable. Eating foods which are high in Vitamin-D or foods that have been prepared with additional vitamins in combination of getting reasonable amounts of exposure to direct sunlight are usually plenty to prevent Vitamin-D deficiency.

III. EDGE BASED IMAGE SEGMENTATION TECHNIQUE

General medical image segmentation methods can be categorized into the following classes: classical image segmentation methods (thresholding, regions-based, and edges-based), to exemplify some of the segmentation technique, we will consider a real X-ray image shown in Fig. 1.

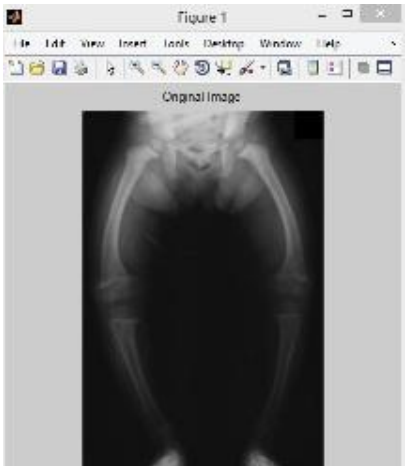

Figure 1. An X-ray for Osteomalacia

Edge-based segmentation methods use edge detectors to find edges in the image. Edge detection has an important role in image processing and computer vision, especially in feature detection and extraction domain. Edges can be viewed as image points, where the luminous intensity of the image changes distinctly along a particular orientation. If the intensity of the images has a strong change, then there is a high probability for an edge at that image position.

Each and every action of detecting edges by using the following operators: Prewitt, Sobel, Roberts and Laplacian of Gaussian (LoG) operator [10]. Most classical edge detectors are based on the local gradient (the first order derivatives) of the image function. Practically, the difference between these operators is that they use different types of filters for estimating the gradient components and a different way for combining these components [9].

Prewitt operator is a discrete operator which estimates the gradient of the image intensity function. It computes the approximations of the derivatives using two 3×3 kernels (masks), in order to find the localized orientation of each pixel in an image. Prewitt differs from Sobel operator only in the filters they use. Prewitt operator used the following filters [9]:

$$H_X^P = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

and

$$H_Y^P = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

The local gradient components are obtained from the filter by scaling:

$$\nabla I(\mathrm{u},\mathrm{v}) \approx \frac{1}{6}\begin{bmatrix} (I * H_x^p)(u,v) \\ (I * H_y^p)(\mathrm{u},\mathrm{v}) \end{bmatrix}$$

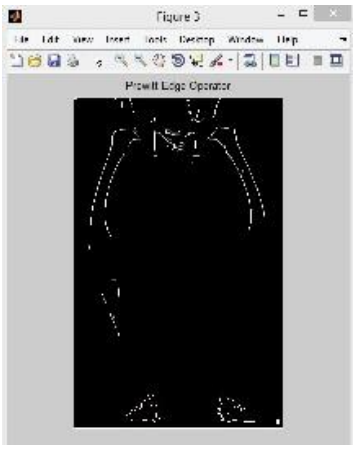

Figure 2. X-ray image segmentation using Prewitt.

Sobel operator computes the approximation of gradients along the horizontal (x) and the vertical (y) directions (2D spatial) of the image intensity function, at each pixel [2], and highlights regions corresponding to edges. Sobel edge detection is implemented using two 3x3 convolution masks or kernels, one for horizontal direction, and the other for vertical direction in an image, that approximate the derivative along the two directions [4].

Sobel operator uses the following filters:

$$H_x^s = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix}$$

and

$$H_y^s = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

The two filters are almost identical with the filters used by Prewitt operator, excepting the weighting of the middle row (for horizontal kernel) and column (for vertical kernel): Sobel uses a weighting of 2 and -2, while Prewitt uses a weighting of 1 and-1.

The local gradient components are computed as follows:

$$\nabla I(\mathrm{u},\mathrm{v}) \approx \frac{1}{8}\begin{bmatrix} (I * H_x^s)(u,v) \\ (I * H_y^s)(\mathrm{u},\mathrm{v}) \end{bmatrix}$$

An example of Vitamin-D disorder image segmentation using Sobel is presented in Fig. 3. In this case the contour of the ankle bones and bowed legs because of rickets and Osteomalacia images. It can be described with well-formed bones of the legs with using affected bones of the above described disease. The top of the fingers' bones can be observed. Moreover, not only the hands' skeleton is detected, but also contours of the hand/arm, which can be observed at the bottom of the image in Fig. 2.

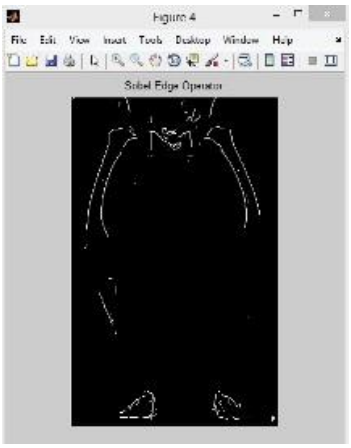

Figure 3. X-ray image segmentation using Sobel.

***Roberts* (Roberts' Cross operator)** is one of the oldest edge detectors. It is a simple operator that approximates the image gradient along the horizontal and the vertical directions, using discrete differentiation and emphasizes regions corresponding to edges (regions with a high spatial frequency) [30].

The filters used by Roberts detector are:

$$H_x^R = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$$

and

$$H_y^R = \begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$$

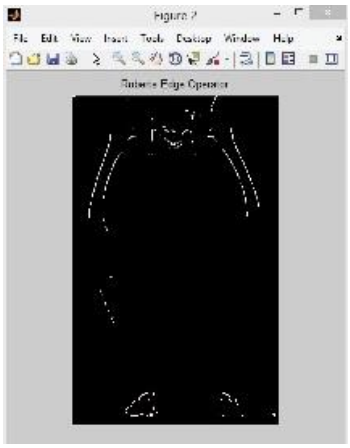

Figure 4. X-ray image segmentation using Roberts.

A small size of filter is a major disadvantage while using Roberts' Cross operator.

Laplacian of Gaussian (LoG) operator computes the second-order derivatives of the intensity function for a given image. The image is smoothed using a Gaussian smoothing filter, to reduce its sensitivity to noise, and then the Laplacian filter is applied. The edges obtained using LoG operator, have a more precise localization than the ones detected by applying Prewitt or Sobel [9].

More advanced edge detectors have been proposed in the computer vision literature such as Harris detector or Canny edge detector. *Harris* finds the edges based on the Eigen values of the Hessian matrix [2]. *Canny* is a very effective edge detecting technique. It detects faint edges, even when the image is noisy, because it is used after a series of pre-

processing procedures, such as edge enhancement (Gaussian filtering). Next, the edge strength (magnitude) of the image must be found. This procedure implies the approximation of the image gradient in the x-direction (G_x) and in the in the y-direction (G_y), using Sobel operator. The gradient magnitudes are determined using the formula:

$$|G| = \sqrt{G_x^2 + G_y^2}$$

The next step consists in finding the edge direction, as shown in the following equation:

$$\theta = arctag\left(\frac{G_y}{G_x}\right)$$

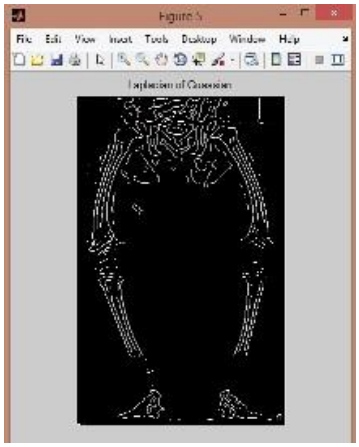

Figure 5. X-ray image segmentation by using LOG Operator.

The purpose of the next step, called non-maximum suppression, is to keep only edge-pixels, in the image of the gradient magnitudes, where the gradient has local maxima. The pixels are separated into edge pixels or non-edge pixels.

The disadvantage of edge-based segmentation algorithms is that they are sensitive to noise and tend to find edges which are irrelevant to the real boundary of the object. For example, in Fig. 4 are detected two edge boundaries, one of the flesh and one for the bone. But, usually, only the bone needs to be separated. Another problem that could appear is that the extracted edges could be disjoint and cannot completely represent the boundary of an object. Such a case is shown in Fig. 2. Therefore, some additional processing is needed to connect them to form closed and connected object regions [2]. Edge detection including Sobel, Prewitt, Roberts or Canny detectors) was used in [14], [23] and [26]. In [40] a computer based automatic tool used for the diagnosis in prosthesed hip has been proposed. One step in the algorithm is the bone and prosthesis segmentation, which is used to produce clinical relevant measurements. The best results for identifying the prosthesis were found using Expectation-Maximization algorithm and Canny.

IV. CONCLUSION

This paper deals with edge based segmentation approach that have been published in the recent literature, concerning Vitamin-D disorder image segmentation. We provided an overview regarding the implementation of edge based segmentation method, highlighting advantages and disadvantages. The evaluation of this segmentation technique can be done, in terms of: performance, sensitivity to noise, computational complexity, or the necessity of training phase. The most accurate techniques are the most complex and time consuming. Finally these images are segmented in order to analyze this Vitamin-D deficiency X-ray images to rectify that problem through doctors advisement. Previously described operators are completely shows the affected area of the bone because of the rickets for children and Osteomalacia for adults.

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